Rotation effects and profitability of safflower compared to wheat and oilseeds in southern Australia

Adam Dellwo[1,2], **Rob Norton**[1], Nick Wachsmann[1] and David Jochinke[1]

[1] Joint Centre for Crop Innovation, The University of Melbourne, Horsham, Vic 3401.
www.jcci.unimelb.edu.au
Email adam.dellwo@elders.com.au, rnorton@unimelb.edu.au, nwachsma@netconnect.com.au, carl@wimmera.com.au
[2] Current location; Elders Pty Ltd, Deniliquin, NSW 2710. www.elders.com.au

Abstract

Four field experiments were undertaken in south western Victoria to compare safflower yield with wheat, canola, mustard and linseed. The sites differed on the amount of stored soil moisture and where the highest stored water was available safflower performed the best, although wheat consistently provided the highest grain yields across all sites. Based on typical crop costs and prices, wheat had the highest gross margin at three of the four sites, with canola usually the second most profitable crop. Safflower showed the lowest returns of the crops on the two central Wimmera rain-fed sites. However, where there was significant rainfall or the soil profile approach field capacity, the returns from safflower approached or exceeded the returns from wheat and canola. Breakeven yield for safflower was estimated at 0.54 t/ha, and across the four sites, safflower produced positive gross margins on three occasions. When the areas were re-sown to wheat in the subsequent year, there were no differences in wheat yield attributable to biotic or abiotic effects associated with the prior crops. Wheat re-cropped in 2001 on the 2000 crop comparisons yielded 2.2 t/ha at one site and 4.4 t/ha at the other. In 2002, all the wheat sown on areas cropped in 2001 failed due to drought, although where the land was fallowed, wheat yields averaged 1.2 t/ha.

Media summary

Safflower is a low cost crop that can provide returns as good as wheat and canola where there is adequate water supply.

Key Words

Winter oilseeds, safflower, rotations, gross margins, yield.

Introduction

Safflower (*Carthamus tinctorius*) is a relatively minor crop in southeastern Australia, with around 30,000 t produced annually. Safflower is often sown in seasons where wet winters delay sowing of winter cereals and oilseeds, a factor that contributes to large variation in annual production and consequently swings in prices and crop profitability. Oilseeds such as safflower offer growers profitable crop options that can disrupt the life cycle of soil borne cereal pathogens (Kirkegaard *et al*. 1994). However, canola is not adapted to all situations and farming systems could benefit from a wider array of profitable crop options. Safflower is a winter-spring growing oilseed, with the capacity to extract water from deep in the soil profile with its aggressive tap root (Wachsmann *et al*. 2003).

A survey of growers in southern Australia (Wachsmann *et al.* 2001) established that the “de-watering” of soil profiles by safflower was considered beneficial by some growers as it reduced the severity of waterlogging in crops planted in the following season. In contrast, other growers believed that safflower’s high water use disadvantaged subsequent crops where rainfall was inadequate to replenish soil reserves. The same survey identified that many growers saw the crop as useful as a tool for integrated pest and weed management, but despite those roles, improved profitability, through high yields and prices, was critical for the future of the crop (Wachsmann *et al.* 2001). Wachsmann *et al*. (2003) compared the yields and water use of safflower with canola quality mustard (*Brassica juncea*), canola (*Brassica napus*), wheat (*Triticum aestivum*) and linseed (*Linum usitatissimum*) at four sites in the Wimmera over two years. This paper presents an economic analysis of those results, as well as data on the effect of these crops and a fallow on subsequent wheat yields.

Methods

Yield of wheat and oilseeds

The two experiments commenced in 2000 were located at Longerenong (36.7?S, 142.3?E) in the central Wimmera of Victoria (LRF00) and Minimay (36.6?S, 141.1?E) near the Victorian/South Australian border (MRF00). A further two experiments were established at Longerenong in 2001, one being rainfed (LRF01) and the other being pre-irrigated with ~200 mm of water (LPW01). All sites had clay soils and crops were sown at recommended seeding rates in mid-winter. The soil water content is expressed volumetrically and was estimated by taking cores of 42 mm aperture to 2 m depth prior to sowing and when each crop physiological maturity (PM). Total water use (TWU) is expressed as the change in soil moisture, plus rainfall over the period. Depending on the site year, plot size ranged from 3.2 ? 10 m to 3.4 ? 20 m. Crop yields are in t/ha at 8% moisture content. Further details on the sites, sowing dates and cultivars used are described in Wachsmann *et al.* (2003).

Economic analysis

Gross margins ($/ha) and breakeven yields were calculated for all crops using typical inputs and costs used by growers in the Wimmera. Grain prices used are averages from recent harvest returns in 2002 and 2003. Delivery costs were estimated for road transport from Horsham to Portland. Herbicide costs were derived from local resellers. The prices used are $190/t for wheat, $340/t for canola and $320/t for linseed, safflower and mustard. Crop levies (1.02% on farm value) and crop insurance have been included at $14 per $1000 of crop value for safflower, canola, mustard and linseed and wheat at $8.35 per $1000 of crop value. Seed costs were based on farmer saved and treated seed at sowing rates of 75 kg/ha (wheat), 40 kg/ha (linseed), 17 kg/ha (safflower) and 4 kg/ha (canola and mustard). All other costs were adapted from Anon. (2002) and Dellwo (unpublished data).

Table 1. Agronomic inputs and cost data used to calculate gross margins. See disclaimer at end of paper on pesticides used in these experiments.

Input Costs	Rates	Unit Costs	Cost/ha	Crop*
		Fertiliser		
Urea	60 kg/ha	$350.00 per t	$21	W,C,S,L,M
Urea	40 kg/ha	$350.00 per t	$14	M
0:14:0:6:2 (N:P:K:S:Zn)	75 kg/ha	$400.00 per t	$30	W,C,S,L,M
		Herbicides		
Glyphosate (presowing)	1 l/ha	5.75 per l	$6	W,C,S,L,M

Trifluralin (presowing)	0.8 l/ha	$8.20 per l	$7	W,C,S,L,M
Metsulfuron (postsowing)	5 g/ha	$0.30 per g	$2	S
Diclofop-methyl (postsowing)	1 l/ha	$18.75 per l	$19	W,
MCPA Amine (postsowing)	1 l/ha	$5.60 per l	$6	W,
Haloxyfop (postsowing)	0.05 l/ha	$226.00 per l	$11	C,S,L,M
Clopyralid (postsowing l)	0.3 l/ha	$62.00 per l	$19	C,M
Insecticides to control				
Rutherglen bug (Lamdacyhalothrin)	1.50 l/ha	$6.00 per l	$9	S
Earthmite control (Chlorpyriphos)	0.14 l/ha	$12.25 per l	$2	C,L,M
Earthmite border spray (Endosulfan)	0.5 l	$12.00 per l	$1	C,L,M
Other Costs				
Fuels and Oil (based on minimum tillage)		$18.35 per ha	$18	W,C,S,L,M
Repairs & Maintenance		$25.39 per ha	$25	W,C,S,L,M
Windrowing		$25.00 per ha	$25	C
Aerial Spraying		$10.00 per ha	$10	S
Crop Insurance		$14.00 per $`000	Variable	C,S,L,M
Crop Insurance		$8.35 per $`000	Variable	W
Cartage (local)		$3.00 per t	Variable	W,C,S,L,M
Freight (Portland)		$20.00 per t	Variable	W,C,S,L,M

Handling Charges		$20.00 per t	Variable	W

* W=wheat, C=canola, S=safflower, L=linseed, M=mustard.

Effect of the previous crop or fallow on wheat yields in the subsequent season

Stubble from previous crops was removed after harvest and the areas maintained weed free with glyphosate until they were lightly cultivate prior to sowing. Trifluralin was applied prior to sowing and incorporated whilst pre-drilling the fertiliser using rates listed in table 1. Wheat (cv. Goldmark) was sown at 70 kg/ha on June 25 (LRF00) and June 19 (MRF00) in 2001, and 75 kg/ha on July 11 (LRF01 and LPW01) in 2002. Mixtures of diclofop and fenoxaprop, and bromoxynil and diflufenican were used for post-emergent weed control at LRF00, but no post emergent herbicides were used at the other site years. Soil water status was measured prior to sowing and at PM using the methods described above. In 2001, treatments were visually evaluated for root and head diseases at flowering and PM. In 2002, no observations were taken.

Results and discussion

Yield and gross margins of wheat and oilseeds

All seasons at Longerenong were drier than average, with April to December rainfall being 278 mm in 2000 and 293 mm in 2001, compared to the long term mean of 349 mm. MRF00 received near average rainfall, with 463 mm falling during this period in 2000. Seed yields for each of the crops at the four sites are given in Table 2, with differences between site years reflecting water availability with total water use at each site being 243, 361, 288 and 413 mm at LRF00, MRF00, LRF01 and LPW01 respectively. MRF00 suffered from a period of waterlogging in September, with wheat and linseed being more severely affected than the other crops. This may have contributed to the non significant result for seed yield in this site year. Wheat produced the highest seed yield on all sites, with canola and mustard proving to be the most reliable oilseeds, although linseed produced similar yields to the other oilseeds in the driest situation (LRF00). Safflower yields fluctuated widely with water availability, being significantly lower than all other crops the two drier site years, but similar to canola in the wetter site years (MRF00 and LPW01).

Table 2. Seed yields (t/ha) and gross margins ($/ha) for wheat, mustard, canola, linseed and safflower at the four sites. Mean yield with the same superscript are not significantly different at *P*=0.05.

Crop	Average Costs $/ha	LRF00		MRF00		LRF01		LPW01		Break even yield t/ha
		t/ha	$/ha	t/ha	$/ha	t/ha	$/ha	t/ha	$/ha	
Wheat	158	2.05 [c]	185	2.91	326	4.18 [d]	534	6.04 [d]	829	1.25
Mustard	171	0.81 [b]	76	2.70	623	2.01 [c]	423	2.82 [ab]	658	0.63
Canola	214	1.19 [b]	175	2.15	468	1.75 [c]	344	3.44 [bc]	866	0.71
Linseed	173	0.82 [b]	76	1.42	250	1.38 [b]	238	2.78 [a]	643	0.65

Safflower	139	0.35 ^{a}	-29	1.99	447	0.78 ^{a}	96	3.71 ^{c}	790	0.54
LSD (5%)		*0.43*		*n.s.**		*0.32*		*0.66*		

* n.s. denotes not significant at *P*=0.05.

Safflower was the cheapest crop to produce and had the lowest breakeven yield at 0.54 t/ha and at least in economic terms was the lowest risk crop evaluated. Wheat had the highest gross margin at the two drier site years, but mustard (MRF00) or canola (LPW01) were the most profitable crops in the two wetter site years. Compared to the other species, safflower was the least profitable crop on the two Longerenong rainfed sites. However, where there was significant seasonal rainfall (MRF00) or where the soil profile approached field capacity at sowing (LPW01), the returns from safflower approached or exceeded the returns from wheat and canola.

Effect of the prior crop or fallow on wheat yields in the subsequent season

There were no significant differences in total soil water content (TSWC) when wheat sown over the previous experiments at LRF00 or MRF00, and only small differences between crops at LRF01 (Table 3). However, at LPW01, there was less water following safflower than following the other crops sown in the previous season. The fallowed plots had significantly more water than those cropped at LRF01 and LPW01. The difference in the TSWC of the fallow plots between sowing the experiments which compared safflower to other oilseeds and these re-cropping experiments was -14, -3, 29 and – 35 mm at LRF00, MRF00, LRF01 and LPW01, respectively. Practically none of the rainfall received over this period (303 – 465 mm) appeared to have been stored in the soil profile. At Longerenong, most of this water is assumed to have been lost to direct soil evaporation in the dry seasons with few heavy rainfall events. In contrast, deep drainage and runoff may have also contributed to this observation at Minimay.

Rainfall between sowing and crop maturity for these experiments was 274, 342, 108 and 108 mm at LRF00, MRF00, LRF01 and LPW01, respectively. Mean TWU was 255, 383, 144 for LRF00, MRF00 and LRF01 respectively and there were no significant differences between the treatments. Fallow plots at LRF01 were significantly different in TSWC at sowing and yield, but not TWU. In the previous year at LRF00, TSWC and TWU showed no effect due to treatments but wheat yields were higher on the fallowed plots. Both sites sown in 2002 had virtually complete crop failure due to drought.

Table 3. Total soil water content (TSWC) to 2 m depth (mm) at sowing and seed yield (t/ha) of wheat as influenced by the previous crop or fallow in 2001 (LRF00 and MRF00), and in 2002 (LRF01 and LPW01).

Previous crop	LRF00		MRF00		LRF01		LPW01	
	TSWC	Yield	TSWC	Yield	TSWC	Yield	TSWC	Yield
Wheat	594	2.15 ^{a}	635	4.00	637 ^{a}	0.03 ^{a}	665 ^{b}	0.00 ^{a}
Mustard	606	2.25 ^{a}	628	4.23	669 ^{b}	0.02 ^{a}	674 ^{b}	0.02 ^{a}
Canola	590	2.28 ^{a}	601	5.09	648 ^{ab}	0.03 ^{a}	672 ^{b}	0.03 ^{a}

Linola™	605	2.23 [a]	578	4.74	653 [ab]	0.00 [a]	656 [b]	0.02 [a]
Safflower	625	2.17 [a]	580	4.25	625 [a]	0.00 [a]	592 [a]	0.05 [a]
Fallow	664	3.34 [b]	678	3.82	739 [c]	1.14 [b]	850 [c]	1.31 [b]
LSD (5%)	*n.s.*$_{(P=0.14)}$	*0.54* **	*n.s.*	*n.s.*	*28.1*	*0.47* ***	33.6 ***	0.22 ***

[a,b,c] means with the same superscript are not significantly different at P=0.05, $^{***}P < 0.001$, $^{**}P < 0.01$, $^{*}P < 0.05$, n.s. denotes not significant at P=0.05.

There was no evidence of root disease in the areas recropped to wheat in 2001. The sites selected were likely to be low disease pressure due to the rotation, and so any beneficial effects due to disease breaks (*e.g*. Kirkegaard *et al.* 1994) would not be expressed. Of equal interest is that in these relatively dry years, even though safflower used more water than the other crops (Wachsmann *et al*. 2003), it dried the soil effectively down to the lower extractable limit of approximately 540 mm (top 2 m) (Norton 1993) this drier soil did not adversely affect the yield of a subsequent wheat crop.

Conclusion

Safflower is a relatively cheap crop to grow compared to other July sowing options. These data show that safflower performs well where there is adequate soil moisture, and poorly when moisture is limiting. Safflower is more susceptible to dry conditions and represents a bigger risk in low rainfall zones or where there is little or no stored water. When there is adequate stored water or good rains, safflower can produce very good yields and returns. Safflower or any other crop did not adversely affect the subsequent wheat yield and gross margin.

Disclaimer

The pesticides and rates given for crop protection chemicals are indicative only and do not imply that these are appropriate or recommended pesticides in those situations. Growers and advisors must check local regulations concerning registration and crop use directions for all crop protection chemicals.

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